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TR-MMER/RM-73-117

JANUARY 1973

RELIABILITY TEST REPORT
FOR
C-4453/APQ-100 AND C-6410/APQ-109
RADAR INDICATOR CONTROL UNITS

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SERVICE ENGINEERING DIVISION

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RELIABILITY TEST REPORT

Best Available Copy

TR-MMER/RM-73-117

RELIABILITY ENGINEERING

TEST REPORT

Prepared by

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Ogden Air Materiel Area
Hill Air Force Base, Utah 84406

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RELIABILITY TEST REPORT

C-4453/APQ-100 and C-6410/APQ-109
RADAR INDICATOR CONTROL UNITS

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ABSTRACT

This document presents the results of the reliability testing performed on the C-4453/APQ-100 and C-6410/APQ-109 Radar Indicator Control Units (ICUs). This test was in support of the Rivet Haste II program and an essential part of the F-4 fire control system's Increased Reliability of Operational Systems (IROS) program.

The reliability test was organically performed by the OOAMA Service Engineering Division at Hill AFB, Utah

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1.0 INTRODUCTION

1.1 GENERAL

This report has been prepared to describe the results of the reliability testing performed on the C-4453/APQ-100 Radar Indicator Control Unit (ICU). Due to the similarity between the C-4453 and C-6410/APQ-109 ICUs, and since the proposed modification is the same for both units, only the C-4453 ICU was tested. Testing of the C-4453 ICU was accomplished from 21 Sep 1972 through 20 Oct 1972 by OOAMA Service Engineering in the Weapons Guidance Engineering Test Facility at Hill AFB, Utah.

1.2 TEST OBJECTIVES

The objective of the testing was to establish a reliability baseline for the unmodified units and compare this baseline with that of the modified units. The test objectives briefly stated are:

(1) To determine the acceptance/rejection of the proposed reliability improvement of the modifications outlined in OOAMA Service Engineering Report TR-MMER/RM-72-102, Operating the DOD with Less Money and Less Manpower. The determination will be in accordance with paragraph 2.3 of OOAMA Reliability Test Plan, TP-MMER/RM-72-108 (see Appendix C). The accept/reject criteria for the test were constructed utilizing the statistical properties of the F-distribution.

(2) To establish a reliability baseline for the unmodified ICUs. The establishment will be accomplished using the chi-square distribution for confidence.

1.3 APPLICABLE DOCUMENTS

The following documents, of the exact issue shown, were applicable during the reliability test.

TP-MMER/RM-72-108	OOAMA Reliability Test Plan, June 1972
MIL-STD-781B	Reliability Tests: Exponential Distribution Notice 1, 15 November 1967
T.O. 12P2-2APQ-2-4	Field Maintenance Instructions Radar Set, Type AN/APQ-100, Vol. IV (Westinghouse) -F4C. Change 7, 1 February 1972
T.O. 33D5-12-172-1	Operator and Service Instructions with IPB - Indicator and Indicator Control Test Station, PN 401R507G01 (Westinghouse) (Conf - Gp 3). Change dated 1 June 1969.
T-7120605	Inspection Test Procedures for Indicator Control and Semi-Composite of Indicator System for AN/APQ-100 (Westinghouse). Revision J, 6 January 1965.
T-712603	Inspection Test Procedure for B-Gun Circuitry for AN/APQ-100 Indicator Control (Westinghouse). 15 June 1965

T-712602 Inspection Test Procedure for A-Gun Circuitry for AN/APQ-100 Indicator Control (Westinghouse). Revision H, 18 June 1965.

2.0 SUMMARY

All the test objectives were met during the reliability test.

The modified units experienced eleven (11) relevant failures in 241.36 cumulative operating hours. The testing of the units was terminated after the tenth failure was verified, however, the testing was continued during the verification analysis and another failure ccurred. Two nonrelevant failures also occurred on the modified units.

The unmodified units experienced seven (7) relevant failures in 248.41 cumulative operating hours. The unmodified units did not experience a nonrelevant failure.

In total, twenty (20) failures occurred during the reliability test. Thirteen (13) of these attributed to the modified units and seven (7) attributed to the unmodified units.

3.0 CONCLUSIONS/RECOMMENDATIONS

3.1 RELIABILITY IMPROVEMENT

The reliability requirement for the proposed modification was a minimum acceptable improvement factor of 3.6. A total of eleven (11) relevant failures on the modified units and seven (7) relevant failures on the unmodified units in 241.36 and 248.41 respective hours of cumulative operating time is sufficient to reject the proposed modification. The proposed modification does not meet the reliability requirement.

The actual demonstrated improvement factor, at a 90 percent two-sided confidence level, is between 0.26 and 1.32. In other words, it can be said with 90 percent confidence that the MTBF of the modified units is at least 0.26 and not more than 1.32 times that of the unmodified units.

3.2 RELIABILITY BASELINE

The unmodified (standard configuration) units experienced seven (7) relevant failures in 248.41 cumulative operating hours. At the 90 percent two-sided confidence level, this results in a MTBF between 20.98 hours and 75.61 hours. In other words, it can be said with 90 percent confidence that the MTBF of the unmodified units is at least 20.98 hours and not greater than 75.61 hours.

3.3 OBSERVATIONS/RECOMMENDATIONS

The following observations and/or recommendations are provided based on the test results.

(1) The proposed modification does not provide the required reliability improvement. Incorporation of this modification is not recommended.

(2) Temperature sensitivity was a continual problem during the test. In most cases this sensitivity created marginal conditions which returned to normal at ambient temperature. There were three relevant failures which were directly attributed to heat problems. It is recommended that an engineering investigation be conducted to determine exact operational temperature environments and their effect on the radar operation.

(3) Approximately 70 percent of the field failure maintenance actions reported on the ICU are adjustments. The test failures were all catastrophic component failures with no adjustment failures observed. During testing, the ICUs were exposed to vibration and temperature cycling, however, the inputs were held at ± 1% of the nominal value. It therefore appears that the adjustment failures in the field are due to system instability or system integration problems. It is recommended that testing be conducted on the entire radar system to check for instability from one line replaceable unit (LRU) to another and to check for system integration problems.

4.0 TEST DESCRIPTION

The following comments are provided to describe the testing accomplished.

(1) Testing was accomplished in accordance with MIL-STD-781B, Test Level E, and OOAMA Reliability Test Plan TP-MMER/RM-72-108, dated June 1972 (see appendix C).

(2) Specimens for the test included a total of seven ICUs. Three of these units were standard configuration units overhauled by depot level maintenance. The remaining four units were depot overhauled units modified to incorporate the proposed changes. Six units, three modified and three unmodified, were under test at one time.

(3) A temperature survey was performed in accordance with MIL-STD-781B, paragraph 5.1.5, at the limits of the temperature cycling ($-54^{\circ}C$ and $+55^{\circ}C$) to determine the time required to stabilize the component of greatest thermal inertia. Temperature sensors mounted on the ICU chasses were used to determine the actual temperature of the units. A total of 62 minutes was found sufficient to cool the equipment to a temperature of $-54^{\circ}C \pm 2^{\circ}C$ from an initial room ambient temperature. With the equipment operating and the chamber heating, a total of 46 minutes was found sufficient to obtain a stable equipment temperature of $+55^{\circ}C$. An additional

120 minutes of operation was conducted in this mode. With the equipment still operating and the chamber cooling, a total of 40 minutes was found sufficient to return the equipment temperature to room ambient. Considering a 5 minute warm-up period after turn-on at the cold temperature extreme, one complete test cycle required 273 minutes (4.55 hours) of which 206 minutes (3.43 hours) was valid equipment "on-time". No environmental air was supplied to the test specimens during the temperature survey or the actual test.

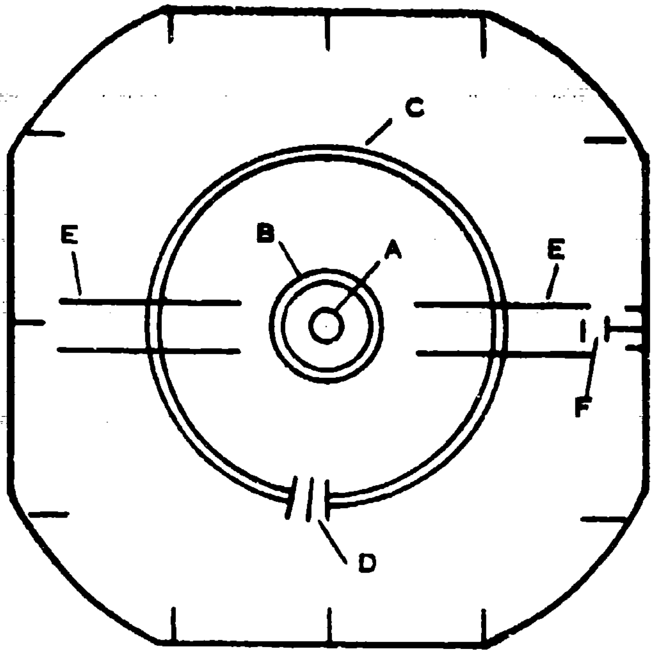
(4) A vibration survey was performed in accordance with MIL-STD-781B, paragraph 5.1.6, in order to identify a non-resonant frequency between 0 and 60 Hz at which vibration during the test would be conducted. Accelerometers on the individual ICUs permitted the amplitude to be monitored. One resonant point was detected and placed at approximately 30 Hz. This was determined to be a resonant frequency for the shock isolators between the case and main chassis. During the actual conduct of the test, the shaker table was adjusted to produce a nominal frequency of 50 Hz with a peak acceleration of 2.2G$\pm$ 0.2G measured at the ICU mounts. The shaker table provided vibration only in a vertical axis, however, the test specimens were mounted such that

one of the modified and unmodified units was oriented in each of three rectangular axes (see Figure 2, Appendix C).

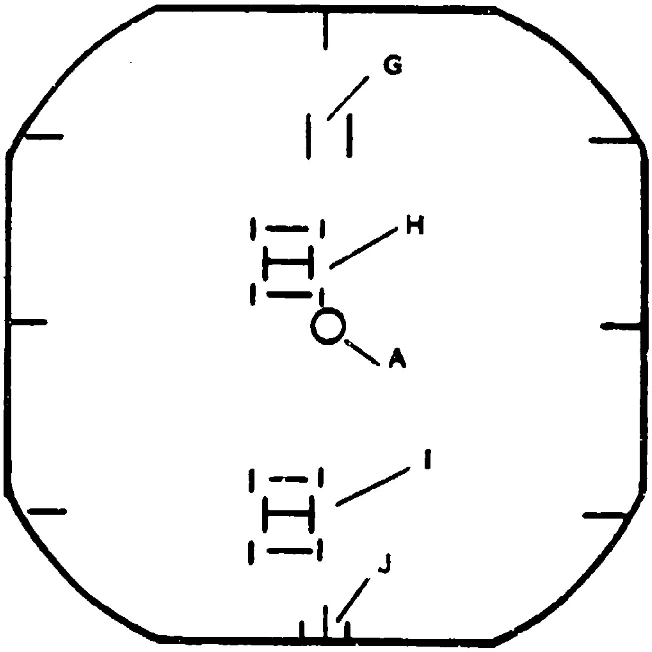
(5) Simulated power and signal inputs were provided in each test specimen by use of laboratory test equipment. All inputs were maintained at ±1% of their nominal values. The inputs were distributed and controlled through two specially designed switching panels. A mode switching panel provided control of the inputs required for each mode of radar operation. A power/signal switching panel provided control of the inputs to each individual test specimen plus master control of all inputs. The later panel provided the capability to shut down one test specimen in case of a failure without interrupting the inputs to the other specimens or shut down all inputs in case of an emergency.

(6) The ICU outputs were monitored by using a single set of actual aircraft radar indicators. One set of radar indicators is one observer (RO) indicator and one pilot indicator. Overlays were constructed to fit over the display tubes on the indicators and tolerance bands were marked on the overlays for each display symbol. The tolerance bands were determined by the allowable deflection from the nominal position (inches deflection) for each symbol as specified in the applicable documents (see Figure 1). A specially designed

switching panel allowed each ICU to be monitored individually by the single set of indicators.



OVERLAY #1



OVERLAY #2

LEGEND

A AIM DOT
B ASE CIRCLE
C RANGE RATE CIRCLE
D RANGE RATE GAP
E HORIZON LINE
F L-STROBE
G ACQ SYMBOL
H R-MAX
I R-MIN
J B-SWEEP

FIGURE 1. OVERLAYS – MONITORING INDICATORS

5.0 RELIABILITY ANALYSIS

5.1 RELIABILITY DATA

Table I contains a complete listing of the relevant failures that occurred on the modified units during the testing. Table II contains a complete listing of the relevant failures that occurred on the unmodified units during the testing. The "Report No." corresponds to the failure report number contained in the listing of all failures in paragraph 6.3. The "Cumulative Test Hours" refers to cumulative equipment "on-time".

TABLE I

Failure No.	Report No.	Cumulative Test Hours
1	003	30.42
2	004	50.35
3	005	96.58
4	00[illegible]	101.59
5	008	106.34
6	011	114.76
7	012	116.76
8	015	164.40
9	017	186.41
10	018	191.42
11	019	206.66

TABLE II

Failure No.	Report No.	Cumulative Test Hours
1	002	8.01
2	007	110.10
3	010	114.10
4	013	123.99
5	014	123.99
6	016	176.19
7	020	244.07

5.2 IMPROVEMENT FACTOR ANALYSIS

The reliability requirement for the proposed modification was a minimum acceptable improvement factor of 3.6. A total of 11 relevant failures on the modified units and 7 relevant failures on the unmodified units in 241.36 and 248.41 respective hours of cumulative operating time is sufficient to reject the proposed modification for not meeting its requirement.

The actual demonstrated improvement factor at the 90% two-sided confidence level is calculated using the F-distribution. For this test, truncation was accomplished on time for the modified units and on a failure for the unmodified units. The applicable mathematical equation for calculating confidence limits is as follows:

$$\frac{\theta_1}{\theta_2} = \frac{\hat{\theta}_1}{\hat{\theta}_2} \times F_{2r_2,\ 2(r_1 + 1)}$$

MTBF point estimates: $\hat{\theta}_1 = \frac{T_1}{r_1}$ and $\hat{\theta}_2 = \frac{T_2}{r_2}$

Definitions: θ_1 = true MTBF of modified units

θ_2 = true MTBF of unmodified units

T_1 = total operating time on modified units

r_1 = total relevant failures on modified units

T_2 = total operating time on unmodified units

r_2 = total relevant failures on unmodified units

Reliability test results:

T_1 = 241.36 and r_1 = 11

T_2 = 248.41 and r_2 = 7

Therefore, $\hat{\theta}_1$ = 21.94 and $\hat{\theta}_2$ = 35.49

Improvement factor point estimate = $\frac{\hat{\theta}_1}{\hat{\theta}_2}$ = 0.62

From Cumulative F-Distribution Tables

$$\text{Prob}\,[0.424 < F_{14,24} < 2.13] = 0.90$$

Therefore $$\text{Prob}\left[(0.62)(0.424) < \frac{\theta_1}{\theta_2} < (0.62)(2.13)\right] = 0.90$$

Hence, the 90% two-sided confidence limits on the true improvement factor are

$$0.26 < \frac{\theta_1}{\theta_2} < 1.32$$

In other words, it can be said with 90% confidence that the MTBF of the modified units is at least 0.26 and not more than 1.32 times that of the unmodified units.

5.3 MTBF BASELINE ANALYSIS

The reliability testing of the unmodified units resulted in 7 relevant failures in 248.41 cumulative operating hours. The demonstrated MTBF at the 90% two-sided confidence level is calculated using the chi-square distribution. The failure truncated mathematical equation for the confidence limits is as follows:

$$\frac{2T_2}{\chi^2_{\frac{\alpha}{2},\ 2r_2}} \leq \theta_2 \leq \frac{2T_2}{\chi^2_{1-\frac{\alpha}{2},\ 2r_2}}$$

The terms θ_2, T_2, r_2 are the same as in the preceding section. The remaining terms are defined as follows:

α = acceptable risk = 0.10

$1-\alpha$ = confidence level = 0.90

$\chi^2_{\alpha,\ 2r_2}$ = α percentage point of chi-square distribution for $2r_2$ degrees of freedom

$$\frac{2(248.41)}{23.685} \leq \theta_2 \leq \frac{2(248.41)}{6.571}$$

Hence, the 90% two-sided confidence limits on the true MTBF of the unmodified units are

$$20.98 \leq \theta_2 \leq 75.61$$

In other words, it can be said with 90% confidence that the MTBF of the unmodified units is at least 20.98 hours and not greater than 75.61

6.0 ENGINEERING FAILURE REPORT SUMMARY

6.1 FAILURE CRITERIA

The following was used as a basis for determining whether a failure had occurred during the reliability test. The determination of whether the failure was relevant or nonrelevant was accomplished according to the guidelines of section 5.4 of the Reliability Test Plan (see Appendix C). The same failure criteria applied to both the modified and unmodified units.

(1) Each ICU must maintain operation within the specified limits during the operating portion of the test cycle. Satisfactory operation is determined by the display symbols remaining within the tolerance bands provided on the display overlays on the monitoring indicators (see Figure 1, Section 4.0).

(2) A symbol that remains within one-eighth of an inch of the specified tolerances will be considered a marginal condition. (NOTE: Extreme temperature sensitivity experienced during the initial phases of the test program necessitated the definitions of the marginal case. During the temperature cycling, the marginal condition was experienced frequently).

(3) A symbol must remain outside the tolerance limits for the entire operating portion of a test cycle. If a symbol

drifts into a marginal condition and then drifts back before the end of the cycle, the occurrence does not constitute a failure.

(4) Satisfactory operation must be achieved immediately following the maximum 5 minute warm-up.

(5) Satisfactory operation must be achieved as presented on both the RO indicator and pilot indicator.

6.2 FAILURE REPORTING FORMAT

Each of the failures experienced during the reliability test was analyzed and is reported in the following format.

UNIT: This is the unit number. The note in parenthesis indicates unmodified or modified unit.

UNIT HOURS: This is the hours of unit "on-time" for the failed unit from the time of the last failure on that unit or from the initial start of testing.

CUMULATIVE HOURS: This is the total hours of "on-time" for the test specimens. Unmodified and modified times are accumulated separately.

SYMPTOMS: The indication of malfunction as observed by the test personnel.

ANALYSIS: Explanation of the cause of failure.

CLASSIFICATION: The relevancy of a failure as jointly agreed upon by OOAMA/MMETA, MMEEA, and MMERR personnel.

6.3 FAILURE REPORT LISTING

The following failure reports are listed in ascending failure number utilizing the format of paragraph 6.2.

Failure No. 001

UNIT:	#5 (modified)
UNIT HOURS:	2.67
CUMULATIVE HOURS:	8.01
SYMPTOMS:	No "B" sweep on RO indicator
ANALYSIS:	Poor connection on circuit card A3724.
CLASSIFICATION:	Nonrelevant.

Failure No. 002

UNIT:	#2 (unmodified)
UNIT HOURS:	2.67
CUMULATIVE HOURS:	8.01
SYMPTOMS:	No expanded sweep on both indicators.
ANALYSIS:	Capacitor C3736 on chassis assembly replaced. Open circuited.
CLASSIFICATION:	Relevant

Failure No. 003

UNIT:	#4 (modified)
UNIT HOURS:	10.25
CUMULATIVE HOURS:	30.42
SYMPTOMS:	No scan on RO indicator
ANALYSIS:	Replaced tube V4 on circuit card A3724.
CLASSIFICATION:	Relevant

Failure No. 004

UNIT:	#6 (modified)
UNIT HOURS:	17.59
CUMULATIVE HOURS:	50.35
SYMPTOMS:	No range rate gap on both indicators.
ANALYSIS:	Heat problems on circuit card A3709. Particular sensitive component (s) could not be isolated. Circuit card replaced.
CLASSIFICATION:	Relevant.

Failure No. 005

UNIT:	#6 (modified)
UNIT HOURS:	14.63
CUMULATIVE HOURS:	96.58
SYMPTOMS:	200 mile range bad on both indicators
ANALYSIS:	Replaced transistor Q9 on circuit Card A3717. Collector-to-base open.
CLASSIFICATION:	Relevant.

Failure No. 006

UNIT:	#6 (modified)
UNIT HOURS:	1.67
CUMULATIVE HOURS:	101.59
SYMPTOMS:	Range rate gap missing on both indicators.
ANALYSIS:	Heat problem on circuit card A3709. Particular sensitive component (s) could not be isolated. Circuit card replaced.
CLASSIFICATION:	Relevant.

Failure No. 007

UNIT:	#3 (unmodified)
UNIT HOURS:	36.81
CUMULATIVE HOURS:	110.1
SYMPTOMS:	No range rate circle on both indicators.
ANALYSIS:	Replaced transistors Q8 and Q9 on circuit card A3706. Both transistors open collector-to-base.
CLASSIFICATION:	Relevant.

Failure No. 008

UNIT:	#5 (modified)
UNIT HOURS:	33.81
CUMULATIVE HOURS:	106.34
SYMPTOMS:	No range rate circle on both indicators.
ANALYSIS:	Replaced tubes V3 and V4 on circuit card A3707
CLASSIFICATION.	Relevant.

Failure No. 009

UNIT:	#6 (modified)
UNIT HOURS:	2.25
CUMULATIVE HOURS:	108.34

SYMPTOMS: No range rate gap on both indicators.
ANALYSIS: Heat problem on circuit card A3709. Circuit card installed after Failure No. 006 was a previously failed card. Card replaced with good item.
CLASSIFICATION: Nonrelevant

<u>Failure No. 010</u>

UNIT: #1 (unmodified)
UNIT HOURS: 38.81
CUMULATIVE HOURS: 114.1
SYMPTOMS: No "B" sweep on both indicators.
ANALYSIS: Replaced transistor Q9 on circuit card A3712.
CLASSIFICATION: Relevant

<u>Failure No. 011</u>

UNIT: #6 (modified)
UNIT HOURS: 1.75
CUMULATIVE HOURS: 114.76
SYMPTOMS: No "B" sweep on RO indicator.
ANALYSIS: Replaced tube V1 on circuit card A3724.
CLASSIFICATION: Relevant.

<u>Failure No. 012</u>

UNIT: #4 (unmodified)
UNIT HOURS: 29.39
CUMULATIVE HOURS: 116.76
SYMPTOMS: No break "X" on both indicators
ANALYSIS: Replaced relay K3702
CLASSIFICATION: Relevant.

<u>Failure No. 013</u>

UNIT: #2 (unmodified)
UNIT HOURS: 41.22
CUMULATIVE HOURS: 123.99
SYMPTOMS: No range rate circle on both indicators.
ANALYSIS: Replaced transistor Q4 on circuit card A3703.
CLASSIFICATION: Relevant

Failure No. 014

UNIT: #2 (unmodified)
UNIT HOURS: 41.22
CUMULATIVE HOURS: 123.99
SYMPTOMS: No ASE circle on both indicators
ANALYSIS: Replaced transistor Q8 on circuit card A3706.
(Note: This failure was determined independent of No. 013).

Failure No. 015

UNIT: #5 (modified)
UNIT HOURS: 19.57
CUMULATIVE HOURS: 164.4
SYMPTOMS: No "B" sweep on pilot indicator
ANALYSIS: Replaced tube V4 on circuit card A3723
CLASSIFICATION: Relevant

Failure No. 016

UNIT: #3 (unmodified)
UNIT HOURS: 23.32
CUMULATIVE HOURS: 176.19
SYMPTOMS: Range rate gap missing on both indicators
ANALYSIS: Heat problem in circuit card A3709. Particular sensitive component(s) could not be isolated. Card replaced.
CLASSIFICATION: Relevant

Failure No. 017

UNIT: #4 (modified)
UNIT HOURS: 23.58
CUMULATIVE HOURS: 186.41
SYMPTOMS: Aim dot port limit bad.
ANALYSIS: Replaced capacitor C3718 on chassis assembly.
CLASSIFICATION: Relevant

Failure No. 018

UNIT: #4 (modified)
UNIT HOURS: 1.67
CUMULATIVE HOURS: 191.42
SYMPTOMS: No "B" sweep on both indicators
ANALYSIS: Replaced tube V1 on circuit card A3724.
CLASSIFICATION: Relevant

Failure No. 019

UNIT:	#5 (modified)
UNIT HOURS:	12.42
CUMULATIVE HOURS:	206.66
SYMPTOMS:	No "E" sweep on both indicators.
ANALYSIS:	Replaced resistor R1 on circuit card A3724. Resistor opened.
CLASSIFICATION:	Relevant

Failure No. 020

UNIT:	#3 (unmodified)
UNIT HOURS:	19.18
CUMULATIVE HOURS:	244.07
SYMPTOMS:	Vertical deflection bad on both indicators.
ANALYSIS:	Replaced capacitors C3718 and C3719 on chassis assembly.
CLASSIFICATION:	Relevant.

APPENDIX A

ENGINEERING TEST EQUIPMENT

ENGINEERING TEST EQUIPMENT

The following contains a listing of test equipment used to conduct the reliability test on the C-4453 Radar Indicator Control Units. A block diagram representing the actual test set up is contained in Figure 1.

Power Inputs

1. Three ±250 VDC Power Supplies, Hewlett Packard, Model 895A.
2. One +300 VDC Power Supply, Hewlett Packard, Model 6448B.
3. Two 0-20 VDC Power Supplies, Hewlett Packard, Model 6286A.
4. One 0-60 VDC Power Supply, Hewlett Packard, Model 6296A.
5. Aircraft Power Generator, type MC-1, Standard Air Force AGE.

Signal Inputs

1. One Pulse Generator, Hewlett Packard, Model 214A.
2. One Pulse Generator, Hewlett Packard, Model 222A.
3. One Standard APQ-100 Scan Pattern Generator, P/N 600R325G01.
4. Standard 115VAC laboratory power (transformed as required).
5. Type MC-1, Aircraft Power Generator (transformed as required).

Test Chamber Equipment

1. Environmental Chamber, Thermotron, Model F-144-CHV-25-25-25-25.
2. Shaker Table, Marshall, Model 211.
3. Chart Recorder, Honeywell, Model 152.

4. Temperature Controller, Honeywell, Model 7284C.

5. Tape Command Unit, Thermotron, Model 1970.

6. Productsaver. Thermotron, Model 1970.

7. Vibration Monitor, L.A.B., Model 382A.

Vibration Survey Equipment

1. Accelerometers, Endevco, Model 2203.

2. Charge Amplifiers, Endevco, Model 2640.

3. D. C. Amplifiers, Dana, Model 3400.

4. Test Oscillator, Hewlett Packard, Model 651A.

5. Voltmeter, Hewlett Packard, Model 400D.

6. Strobotac, General Radio, Model 1531.

Thermal Survey Equipment

1. Sensors, Rosemount, Model 118G.

2. Indicator, Rosemount, Model 431E.

Output Monitoring Equipment

1. Standard APQ-100 Radar Observer Indicator, Type IP-676.

2. Standard APQ-100 Pilot Indicator, Type IP-675.

3. Type MC-1, Aircraft Power Generator.

Switching Equipment

1. Mode Switching Panel, specially constructed.

2. Power/Signal Input Switching Panel, specially constructed.

3. Output Switching Panel, specially constructed.

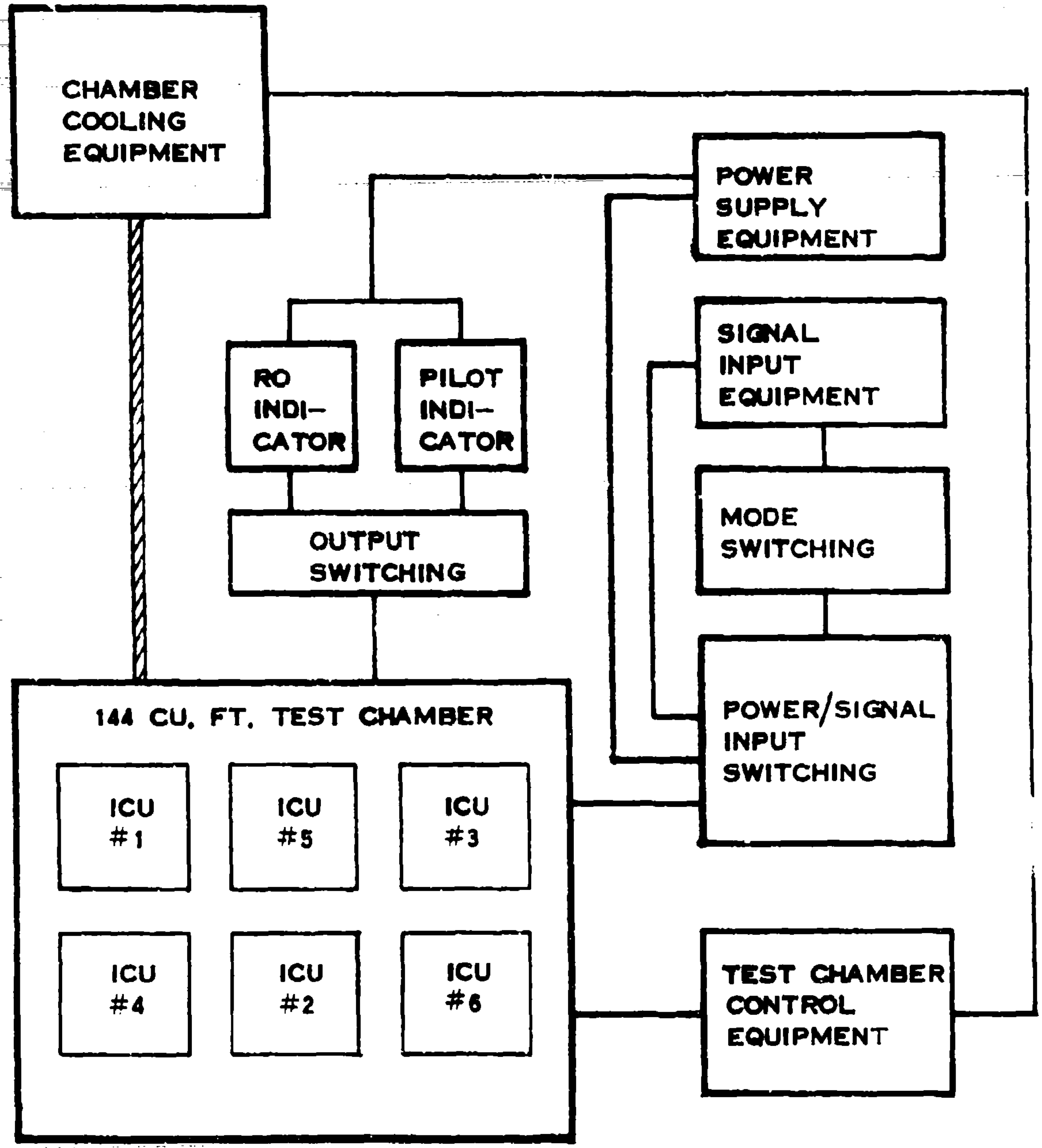


FIGURE 1. TEST EQUIPMENT SCHEMATIC

APPENDIX B

ENGINEERING TEST LOG

ENGINEERING TEST LOG

21 Sep Finalized thermal cycle times.

22 Sep Finalized test procedures for making system checks.

25 Sep Lost freon in chamber cooling system. Freon leaked through relieve valve due to failed timer diode. Caution to be taken that water tower power is on before starting a cooling cycle. There is no interlock in system and no reset light will come on.

26 Sep Test down for chamber repairs.

27 Sep Started final alignment of ICUs to pass test specifications. Range symbols are noisy caused by lead length distorting the B-Gun deflection. PPI scan is narrow due to lead length. These problems will have to be compensated for.

28 Sep Continued ICU alignment. It is noted that there is drift as the symbols are being set up. In the time it takes to set up all six ICUs, the drift occurs in one or more of the ICUs during the set up procedure.

ICU #4 has A-Gun collapse. Unit removed from chamber and installed on mock-up. Checked ok. Unit returned to chamber and checked ok. Cause of problems unknown.

29 Sep Problem with ICU #4 again. Unit rechecked ok. Finished alignment of all six units.

<u>2 Oct</u> Started first test cycle.

ICU #5 - "B" sweep missing on RO indicator.

Unit removed from chamber and installed on mock-up. Loose connection found on card A3724 (Report No. 001)

ICU #4 - Lost BIT 3 presentation. Wire 3703/N found broken on indicators.

ICU #3 - "B" sweep length drifting on RO indicator. Re-adjust A3723/R14 for nominal value. Failure criteria marginal.

ICU #2 - A-Gun drifting to left and expanded sweep bad. Replaced C3736 (installed backwards) and readjusted A3701/R3. (Report No. 002).

Total run time - 3 hours.

<u>4 Oct</u> Cycle #2 - No problems encountered with total run time of 3 hours.

Cycle #3 - Problem with ICU #1. Loose board A3717. Run time, 3.17 hours.

<u>5 Oct</u> Cycle #4 - Problem with ICU #4. Scan problems with PPI and RMAX/RMIN. Replaced board A3724. (Report No. 003) Run time, 3.17 hours.

Cycle #5 - No problems encountered with run time of 3.25 hours.

<u>6 Oct</u> Cycle #6 - Problem with ICU #6. No range rate gap. Replaced board 3709 (Report No. 004) Run time, 3.17 hours.

Cycle #7 - No problems encountered with run time of 3.97 hours.

9 Oct Problem with MC-1 generator. Switch to gasoline standby generator.

Cycle #8 - No problems encountered with run time of 3.33 hours.

Cycle #9 - No problems encountered with run time of 3.08 hours.

Cycle #10 - No problems with run time of 3.17 hours.

Chamber displaying small stability problem during hot cycle.

10 Oct Cycle #11 - Problem with ICU #6. 200 mile range out. Replaced board A3717 (Report No. 005). Anotner problem with ICU #6. No range rate gap. Replaced board A3709 (Report No. 006). Run time 3.25 hours.

Cycle #12 - Problem with ICU #3. No range rate circle. Replaced board A3706 (Report No. 007). Problem with ICU #5. No range rate circle. Replaced board A3707 (Report No. 008) Problem with ICU #6. No range rate gap. Replaced board A3709 (Report No. 009).

Problem with ICU #1. No "B" sweep. Replaced board A3712 (Report No. 010).

Chamber still displaying instability at high temperature. Run time, 3.42 hours.

11 Oct Cycle #13 - Problem with ICU #6. No "B" sweep. Replaced board A3724. (Report No. 011).

Problem with ICU #4. No break "X". Replaced relay K3702 (Report No. 012)

Problem with chamber control. Units were operated additional hour because of malfunction. Test shut down to fix controls.

Run time, 4.16 hours.

12 Oct Cycle #14 - Problem with ICU #2. No range rate gap. No range rate circle. No ASE circle. Replaced boards A3703 and A3706. (Report No. 013 & 014). Realigned ICU #2

Run time, 3.12 hours.

13 Oct. Cycle #15 - No problems encountered with run time of 3.87 hours.

Cycle #16 - No problems encountered with run time of 3.67 hours.

16 Oct Cycle #17 - No problems encountered with run time of 3.5 hours.

Cycle #18 - Problem with ICU #5. No "B" sweep. Replaced board A3723 (Report No. 015)

Run time, 3.75 hours.

17 Oct Cycle #19 - Problem with ICU #3. No range rate gap. Replaced board A3709 (Report No. 016)

Run time, 3.42 hours.

Cycle #20 - Problem with ICU #4. Aim dot port limit bad. Replaced capacitor C3718 (Report No. 017)

Another problem with ICU #4. No "B" sweep. Replaced board A3724 (Report No. 018).

Run time, 3.75 hours.

<u>18 Oct</u> Cycle #21 - No problems encountered with run time of 3.83 hours.

Cycle #22 - Problem with ICU #5. No "B" sweep. Replaced board A3724 (Report No. 019).

Run time, 3.6 hours.

<u>19 Oct</u> Cycle #23 - Peoblem with ICUs #1, #3, #6.

No ACQ symbol. Found 222A generator which supplies pulse inputs was out. No failure problem with ICUs. Run time, 3.33 hours.

Readjusted 222A pulse generator.

<u>20 Oct</u> Cycle #24 - No problems encountered with run time of 3.17 hours.

Cycle #25 - Problem with ICU #3. Vertical deflection bad. Replaced capacitors C3718 and C3719 (Report No. 020).

Failure report Nos 017 and 018 have been verified as relevant failures. Test is truncated according to criteria of test plan after the tenth relevant failure. Test completed.

APPENDIX C

RELIABILITY TEST PLAN

TABLE OF CONTENTS

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FIGURES

TABLES

1.0 INTRODUCTION

1.1 GENERAL

This test plan specifies the reliability demonstration test to be conducted on the C-4453/APQ-100 Radar Indicator Control Unit (ICU) as part of the Rivet Haste II program and the F-4 fire control system Increased Reliability of Operational Systems (IROS) program. Due to the similarity between the C-4453 and C-6410/APQ-109 ICUs, and since the proposed modification is the same for both units, only the C-4453 ICU will be tested.

1.2 PURPOSE OF TEST

The purpose of the testing is to establish reliability parameters for determining the relative improvement between baseline configured (unmodified) C-4453 ICUs and ICUs incorporating the modifications outlined in OOAMA Service Engineering Report TR-MMER/RM-72-102, Operating the DOD with Less Money and Less Manpower. Testing of both the unmodified and modified units will be in accordance with MIL-STD-781B, Test Level E.

1.3 APPLICABLE DOCUMENTS

The following documents, of the exact issue shown, form a part of this test plan to the extent specified herein.

MIL-STD-781B	Reliability Tests: Exponential Distribution Notice 1 dated 15 November 1967
MIL-STD-721B	Definitions of Effectiveness Terms for Reliability, Maintainability, Human Factors, and Safety Notice 1 dated 10 March 1970
T.O. 12P2-2APQ100-2-4	Field Maintenance Instructions - Radar Set, Type AN/APQ-100, Vol. IV (Westinghouse)-F4C Change 7, dated February 1, 1972.

T.O 33D5-12-172-1	Operator and Service Instructions with IPB - Indicator and Indicator Control Test Station, P/N 401R507G01 (Westinghouse) (Conf-Gp 3) Change, dated 1 June 1969
T-7120605	Inspection Test Procedures for Indicator Control and Semi-Composite of Indicator System for AN/APQ-100 (Westinghouse) Revision J, dated 6 January 1965
T-712603	Inspection Test Procedure for B-Gun Circuitry for AN/APQ-100 Indicator Control (Westinghouse) Revision H, dated 15 June 1965
T-712602	Inspection Test Procedure for A-Gun Circuitry for AN/APQ-100 Indicator Control (Westinghouse) Revision H dated 18 June 1965

1.3.1 PRECEDENCE OF DOCUMENTS

In the case of conflict between requirements of this test plan and those contained in the applicable documents, the order of precedence shall be as follows:

a. This Test Plan

b. MIL-STD-781B

c. MIL-STD-721B

d. T-7120605

e. T.O, 33D5-12-172-1

f. T-712603

g T-712602

h. T.O. 12P2-2APQ100-2-4

2.0 GENERAL TEST REQUIREMENTS

2.1 QUANTITY OF TEST SPECIMENS

Three (3) unmodified (baseline) ICUs and four (4) ICUs incorporating the proposed modification.

2.2 TEST LEVEL

Modified Test Level E of MIL-STD-781B shall be used during the testing. The conditions of the modified test level are as follows.

(1) Temperature . . . . . -54°C to +55°C (-65°F to +131°F)

(2) Temperature Cycling . . . . . Temperature Cycling shall be time to stabilize at low temperature, followed by time to stabilize at high temperature, plus 2 hours. See Figure 1 for more detail.

(3) Vibration . . . . . 2.2G ± 10% peak acceleration value at any nonresonant frequency between 20 and 60 Hz measured at the mounting points on the equipment. The duration of vibration shall be least 10 minutes during each hour of operating time. See Figure 1 for more detail

(4) Equipment On-Off Cycling . . . . . Equipment off during portion of cooling cycle from room ambient temperature (80°F) until stabilized lower temperature limit is reached. Equipment on during heating cycle, plus 2 hours operation at stabilized high temperature limit, plus portion of cooling cycle down to room ambient temperature. See Figure 1 for more detail.

(5) Input Voltage . . . . . Nominal specified voltage, ±5%

(6) Input Voltage Cycling . . . . . Not required.

2.3 TEST CRITERIA

The accept and reject criteria for this test were constructed utilizing the statistical properties of the F-distribution. That is, the times-to-failure of both the modified and unmodified units are assumed to follow a negative exponential probability distribution, which is the expected distribution based on past history of complex electronic equipment such as the test units. Based on this assumption, the respective MTBF's of the modified and unmodified units will be Chi-Square distributed. The ratio of two Chi-Square variables, when each is divided by its associated number of degrees of freedom, is F-distributed. Therefore, it can be shown that the ratio of the MTBF's of the modified and unmodified units is F-distributed. The details of this derivation can be found in OOAMA Service Engineering Technical Report TR-MMER/RM-72-110 (to be published).

Utilizing the above theory, critical values were determined for the combination of relevant failures and operating times on the modified and unmodified units required to demonstrate the desired improvement factor. The critical values for the accept criteria are based on demonstrating an improvement factor of 3.6 or greater for the ICU's. The critical values for the reject criteria are based on demonstrating an improvement factor of 3.0 or less for the ICU's. Both the accept and reject criteria are based on a confidence level of 90%.

The optimum test truncation time was determined to be one thousand (1000) accumulative operating hours on both the modifed and unmodified units. This was determined by utilizing the Poisson distribution and comparing the probability of making an accept/reject decision with test time.

Based on this time truncation point, the failure truncation point was determined to be ten (10) failures on the modified units. Test truncation on failures of the unmodified units is not applicable since it depends strictly on the number of failures on the modified units.

A summary of the quantitative requirements of the test criteria is given in Table 1. The accept and reject criteria are given in Tables 2 and 3 respectively.

TABLE 1

SUMMARY OF TEST REQUIREMENTS

D_o = Minimum accept improvement factor = 3.6

D_1 = Maximum reject improvement factor = 3.0

Confidence Level = 90%

Test Truncation Time = 1000 operating hours (on modified and on unmodified units)

Test Failure Truncation = ten failures on modified units

2.4 TEST CYCLE

The test cycle is depicted in Figure 1 and will consist of the following.

(1) With the test specimens non-operating, the test specimen temperature will be reduced to -65°F and maintained until specimen stabilization is reached. The stabilization time is derived from the thermal survey.

(2) Following specimen stabilization, the specimens will be switched on and allowed to warm-up for five (5) minutes. The specimen temperature will then be increased to +131°F.

(3) Application of vibration at the 2.2G ± 10% level, and at the frequency determined in the vibration survey, will be applied to the specimens for ten (10) minutes of each operating hour, beginning with the first hour of operation.

(4) When the specimens have reached +131°F, and have stabilized as determined by the thermal survey, they shall be operated an additional two (2) hours.

(5) Following the two (2) hour operating period, the specimens will be decreased to +80°F at which point the test specimens will be turned off. The specimen temperature will then be decreased to -65°F for start of the next cycle.

TIME RATIO (T_2/T_1) FOR ACCEPT DECISION

r_2 \ r_1	0	1	2	3	4	5	6	7	8	9	10
1	.031	.015	.01	.003	.006	.005	.004	.004	.004	.003	.003
2	.128	.068	.046	.035	.028	.024	.022	.019	.017	.014	.013
3	.241	.131	.091	.07	.057	.048	.043	.039	.034	.029	.027
4	.357	.198	.137	.107	.088	.074	.067	.06	.053	.046	.042
5	.475	.267	.188	.146	.119	.101	.092	.082	.073	.063	.058
6	.593	.336	.238	.185	.152	.129	.117	.105	.093	.091	.074
7	.714	.406	.289	.225	.186	.157	.143	.128	.114	.099	.092
8	.833	.478	.342	.267	.219	.184	.168	.151	.134	.118	.109
9	.952	.547	.392	.306	.253	.212	.193	.174	.155	.136	.126
10	1.07	.618	.443	.347	.287	.239	.218	.197	.176	.155	.143
11	1.19	.689	.494	.389	.319	.271	.247	.223	.195	.174	.161
12	1.31	.760	.546	.429	.353	.303	.276	.248	.221	.193	.178
13	1.43	.831	.597	.472	.389	.333	.303	.272	.242	.212	.196
14	1.56	.903	.650	.514	.422	.361	.331	.297	.364	.231	.213
15	1.65	.973	.701	.554	.458	.892	.356	.321	.286	.250	.231
16	1.79	1.04	.753	.594	.492	.422	.383	.344	.308	.269	.249
17	1.92	1.11	.806	.636	.528	.450	.411	.369	.328	.289	.267
18	2.04	1.19	.858	.678	.561	.481	.436	.394	.350	.308	.283
19	2.16	1.26	.908	.719	.594	.511	.464	.419	.372	.328	.303
20	2.28	1.33	.961	.760	.630	.540	.491	.443	.394	.346	.320
21	2.40	1.40	1.01	.800	.664	.569	.519	.467	.417	.367	.342
22	2.52	1.47	1.06	.842	.700	.600	.544	.492	.439	.383	.350
23	2.64	1.54	1.11	.883	.733	.628	.572	.517	.461	.403	.375
24	2.76	1.61	1.17	.925	.769	.658	.600	.542	.483	.422	.392
25	2.88	1.68	1.22	.965	.803	.689	.627	.566	.504	.443	.410
26	3.00	1.76	1.27	1.01	.839	.719	.656	.592	.525	.461	.428
27	3.12	1.83	1.32	1.05	.872	.750	.683	.614	.547	.481	.447
28	3.24	1.90	1.38	1.09	.908	.778	.708	.639	.569	.500	.464
29	3.36	1.97	1.43	1.13	.942	.808	.736	.664	.592	.519	.433
30	3.48	2.04	1.48	1.17	.977	.839	.764	.689	.615	.540	.500

D_o = 3.6

r_1 = Failures on modified

r_2 = Failures on unmodified

T_1 = Time on modified

T_2 = Time on unmodified

TABLE 2: ACCEPT CRITERIA

LC FORM MAR 65 1926 FC 4700

TIME RATIO (T_2/T_1) FOR
REJECT DECISION

r_2 \ r_1	1	2	3	4	5	6	7	8	9	10		
0	3.00	.720	.383	.260	.103	.157	.139	.122	.104	.087		
1	6.16	1.37	.707	.470	.347	.273	.243	.212	.181	.150		
2	9.33	2.00	1.02	.670	.490	.390	.343	.299	.254	.209		
3	12.49	2.63	1.32	.863	.627	.493	.437	.380	.323	.267		
4	15.65	3.27	1.63	1.07	.773	.617	.543	.470	.397	.323		
5	18.82	3.90	1.97	1.25	.920	.717	.633	.547	.463	.377		
6	21.98	4.53	2.24	1.44	1.06	.820	.727	.627	.530	.433		
7	25.14	5.15	2.55	1.63	1.19	.927	.817	.707	.597	.487		
8	28.37	5.78	2.86	1.83	1.33	1.03	.910	.787	.663	.543		
9	31.47	6.40	3.17	2.02	1.47	1.13	1.00	.867	.730	.597		
10	34.63	7.03	3.46	2.22	1.61	1.25	1.10	.950	.800	.650		
11	37.80	7.66	3.76	2.40	1.74	1.36	1.20	1.03	.867	.700		
12	40.97	8.29	4.06	2.59	1.88	1.47	1.30	1.12	.937	.757		
13	44.13	8.92	4.36	2.78	2.02	1.59	1.39	1.20	1.07	.813		
14	47.30	9.55	4.67	2.98	2.16	1.70	1.49	1.29	1.08	.870		
15	50.47	10.17	4.97	3.17	2.30	1.80	1.58	1.36	1.14	.923		
16	53.63	10.80	5.27	3.36	2.43	1.90	1.67	1.44	1.21	.977		
17	56.80	11.42	5.57	3.55	2.57	2.01	1.76	1.52	1.27	1.03		
18	49.97	12.04	5.87	3.74	2.70	2.11	1.84	1.60	1.34	1.09		
19	63.13	12.67	6.18	3.93	2.84	2.21	1.94	1.68	1.41	1.14		
20	66.29	13.30	6.48	4.13	2.98	2.32	2.04	1.76	1.47	1.19		
21	69.45	13.93	6.78	4.32	3.12	2.24	2.13	1.84	1.54	1.25		
22	72.60	14.57	7.09	4.51	3.26	2.53	2.22	1.91	1.61	1.30		
23	75.76	15.20	7.39	4.70	3.39	2.63	2.31	1.99	1.68	1.36		
24	78.92	15.83	7.69	4.90	3.53	2.74	2.41	2.07	1.74	1.41		
25	82.07	16.46	7.99	5.09	3.67	2.84	2.50	2.15	1.81	1.46		
26	85.23	17.08	8.30	5.28	3.81	2.95	2.59	2.23	1.88	1.52		
27	88.39	17.70	8.60	5.47	3.95	3.05	2.68	2.31	1.94	1.57		
28	91.54	18.33	8.90	5.66	4.08	3.16	2.78	2.39	2.01	1.63		
29	94.70	18.95	9.20	5.85	4.22	3.27	2.87	2.47	2.08	1.68		

D = 3.0
r_1 = Failures on modified
r_2 = Failures on unmodified

T_1 = Time on modified
T_2 = Time on unmodified

TABLE 3: REJECT CRITERIA

AFLC FORM MAR 65 1926 F C 4700

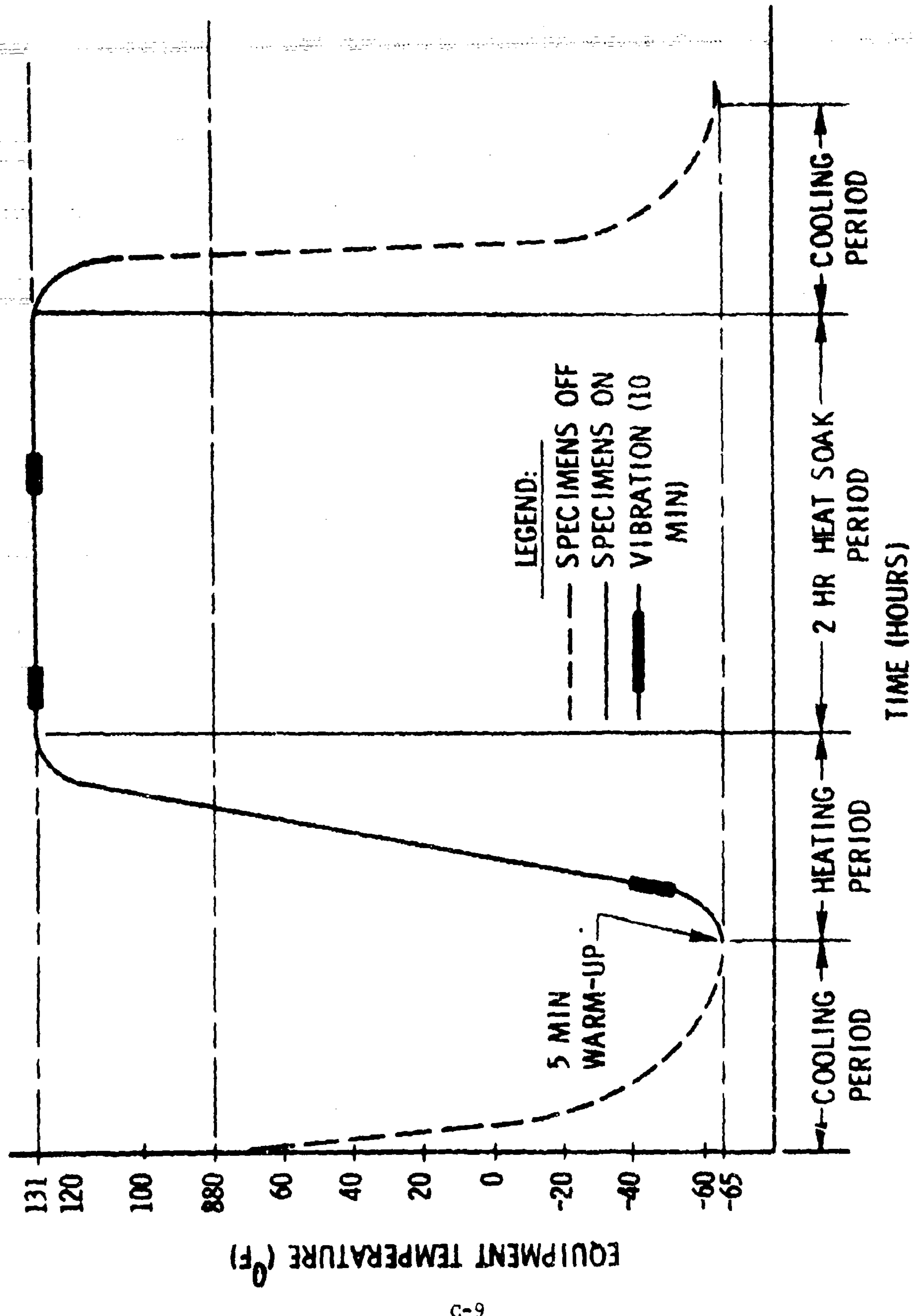

FIGURE 1: TEST CYCLE

3.0 TEST CONFIGURATION AND PROCEDURES

3.1 TEST LOCATION/EQUIPMENT

The test will be conducted by OOAMA/MMETAW in building S-882 at Hill Air Force Base, Utah. The reliability test chamber to be used is a Thermotron model F-144-CHV-25-25-25-25 incorporating a model 211 Marshall vibration unit.

3.2 TEST SPECIMENS AND INSTALLATION

The test specimens consist of four (4) modified and three (3) unmodified ICUs. Three modified and three unmodified specimens will be mounted on a vibration table, in a temperature chamber, including all mechanical and electrical connections required to operate/monitor the specimens. The specimens will be mounted on the vibration table such that one of the modified and unmodified units is oriented in each of three rectangular axes (see Figure 2). No external environmental air shall be generated to the test specimens during the test.

3.3 TEST PROCEDURES

The following procedures shall be utilized to monitor the test specimens during the "on-time" portion of the test cycle. The complete procedure shall be accomplished at least once during each fifteen (15) minutes of equipment "on-time". Each ICU shall be checked by setting switch positions on the control consoles and verifying that the symbols displayed on the radar indicators are within the specifications shown on the indicator scope overlays and verified on the test check-off sheet. The time when each check is accomplished shall be recorded. These procedures are in accordance with applicable technical orders and test specifications and have been approved by OOAMA/MMETAW, MMEEA, and MMERR.

(1) Power Application

a. Power Cart - ON

b. Power Supplies - ON

c. Master Switch - ON

d. Input Supplies - Verify Voltages

e. Indicator Switch - ON

f. Delay Switch - ON after 30 secs.

g. ICU Power - ON

h. ICU Signal - ON

i. ICU Selector - Verify normal display on all six positions (leave on #6)

(2) Mode Switching Panel

a. AI RDR, MAP-B, BST - ON

b. BIT #3 - ON

c. 25 Mile - ON

d. Acquisition - ON

e. Range Lock - ON

f. Track Display - ON

(3) Verify that symbols are within tolerances as outlined on overlay #1 and check on test check-off sheet.

(4) Verify that symbols are within tolerance as outlined on overlay #2 and check on test check-off sheet.

(5) Set Mode Switching Panel to each range setting and verify range switching results per test check-off sheet.

(6) Set Mode Switching Panel on each of the following positions and verify results per test check-off sheet.

a. STAB OUT

b. BREAK X

c. EXPANDED SWEEP

(7) Rotate the ICU Selector through the remaining five positions and repeat steps (3) through (6) for each of the ICUs.

4.0 THERMAL/VIBRATION SURVEY

4.1 THERMAL SURVEY

A thermal survey shall be made of the equipment to be tested, under test level temperature cycling prior to the initiation of testing. The purpose of this survey is to identify the component of greatest thermal inertia and to establish the time temperature relationship between it and the chamber air. This relationship shall be used to determine the thermal stabilization of the equipment during the test. The lower test level temperature stabilization takes place when the temperature of the point of maximum thermal inertia is within $2^{o}C$ of the lower test level temperature and its rate of change is less than $2^{o}C$/hour. Upper test level temperature stabilization takes place when the rate of change of the point of maximum thermal inertia at the upper temperature limit is less than $2^{o}C$/hour. The techniques and results of the thermal survey shall be described by MMETAW and submitted to MMERR. The tests shall be run according to the approved procedures. Temperatures of the heating-cooling air shall be recorded continuously during both survey and testing.

4.2 VIBRATION SURVEY

A vibration survey shall be conducted over the frequency range of 20 to 60 Hz. A nonresonant frequency selected in this range will be used in performing vibration during the Reliability Test. A strobe light will be used to verify that resonant modes are not present. The techniques and results of the vibration survey shall be described by MMETAW and submitted to MMERR.

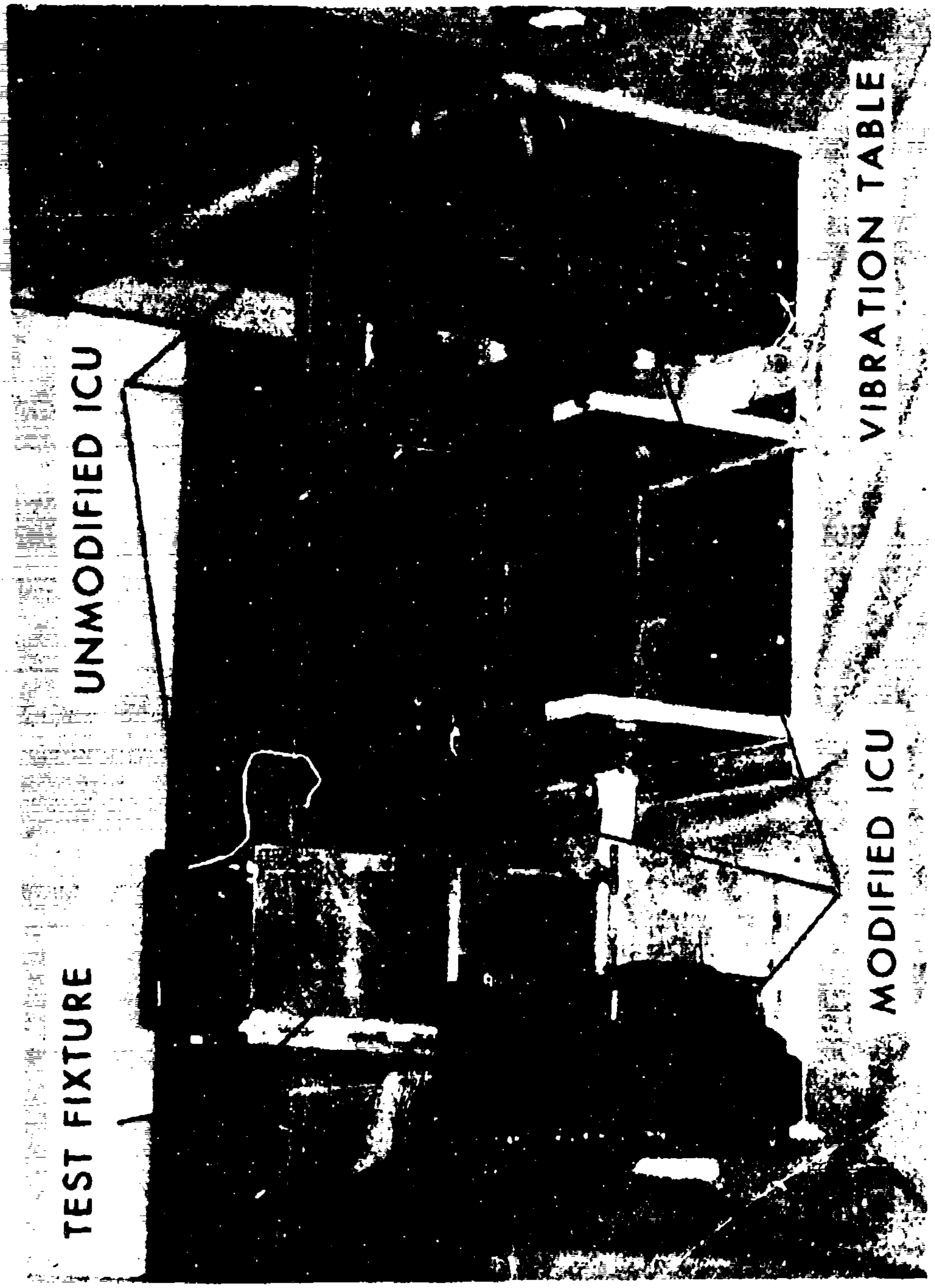

FIGURE 2

TEST SPECIMEN SETUP

5.0 TEST DATA REPORTING

5.1 TEST INSTRUMENTATION REQUIREMENTS

Provisions shall be made to determine that the test specimen inputs are within tolerances (see paragraph 2.2(5)) and that the specimen outputs are within limits as specified in the applicable documents. The chamber temperature shall be monitored and recorded continuously during the test.

5.1.1 INPUT REQUIREMENTS

The following inputs are required for each specimen on test.

(1) Phase A, B, and C power.

(2) B+ DC power.

(3) 28VDC power.

(4) A-Gun inputs

(5) B-Gun inputs

5.1.2 OUT REQUIREMENTS

The following outputs will be monitored for each specimen on test.

(1) Range Rate Circle

(2) ASE Circle.

(3) Aim dot.

(4) Horizon Line

(5) Elevation Strobe

(6) Maximum Range Strobe

(7) Minimum Range Strobe

(8) B Sweep

(9) Acquisition Symbol

(10) Range Rate Gap

5.2 ENGINEERING TEST PROJECT LOG

An Operational Information Log shall be maintained during all operations of the test specimens. This log shall be used to record elapsed time readings, operating time, accumulated time and signature of observer. Remarks shall be included which record significant events or notes applicable to the periods of operation. Figure 3 is the Engineering Test Project Log that will be used.

5.3 FAILURE REPORTING

Whenever a discrepancy occurs, a failure report shall be initiated to record the event and describe the discrepancy. A failure analysis report shall be initiated following analysis and ultimate resolution of the problem. Figures 4 and 5, respectively, are the Item Failure and Failure Analysis Reports.

5.4 FAILURE CRITERIA

During this reliability test, the failure criteria of MIL-STD-721B as clarified/amplified in this test plan shall apply. A failure is defined as any catastrophic cessation of function in any part of the test specimens or any degradation such that the related performance cannot be maintained within the specified tolerances.

5.4.1 RELEVANT FAILURE CRITERIA

A relevant failure is any verified failure, as defined above, that cannot be classified as a nonrelevant failure in accordance with the criteria of paragraph 5.4.2.

In the event that a discrepancy is noted for which there is no set failure criteria, that discrepancy will be recorded in the test log along with

ENGINEERING TEST PROJECT LOG	PAGE OF PAGES
1. TYPE TEST	2. EQUIPMENT TESTED

DATE A	TIME B	COMMENTS/ACTION C	INITIALS D

FIGURE 3: ENGINEERING TEST PROJECT LOG

ITEM FAILURE REPORT			1. Report Number
2. Failed Part Name	3. Failed P/N	4. Serial No.	5. Mfgr.
	6. MOD No.	7. Appl. TCTO/ECP	8. Project No.
9. Next Higher Assy	10. NHA P/N	11. NHA S/N	12. Mfgr.
13. System	14. System S/N	15. Model	16. Follow-up Rpt No.
17. Failure Discovered During (Check) ☐ Thermal Survey ☐ Vibration Survey ☐ Repair Verif. ☐ Reliability Demo. ☐ Other		18. Test Location	19. Test Plan
20. FAILURE DESCRIPTION, PRELIMINARY DIAGNOSIS, TEST CONDITIONS			
21. Cause of Failure or Stress (Check) ☐ Assembly ☐ Workmanship ☐ Part ☐ Design ☐ Material ☐ Other ☐ Test Equip.		22. Disposition	23. Operating Time
		24. Fail Date	25. Time
26.	27.	28. Reported By	29. Page ____ Of ____

FIGURE 4: ITEM FAILURE REPORT

FAILURE ANALYSES REPORT			1. Report Number
2. Failed Part Name	3. Failed P/N	4. Serial No.	5. Failure Date
	6. MOD No.	7. Mfgr	8. Failure Rpt No.
9. Next Higher Assy	10. NHA P/N	11. NHA S/N	12. Project No.
13. System	14. System S/N	15. Model	16. NHA Mfgr
17. Cause of Failure (Check) ☐ Assembly ☐ Other ☐ Part ☐ Material ☐ Test Equip ☐ Workmanship ☐ Design		18. Stress Causing Damage (Check) ☐ Electrical ☐ Other ☐ Mechanical ☐ Pressure ☐ Temperature ☐ Humidity ☐ Overload	
19. DESCRIPTION OF FAILURE 20. ANALYSES OF FAILURE			
21. CORRECTIVE ACTION			
22. Analyzed By		23. Date	24. Page____ Of____

FIGURE 5: FAILURE ANALYSIS REPORT

related information and corrective actions required. MMETAW, MMEEA, and MMERR personnel will then review the test log data and determine whether the discrepancy should be classified as a relevant or nonrelevant failure.

5.4.2 NON RELEVANT FAILURE CRITERIA

A failure of a test specimen caused by a condition external to the system under test which is not a test requirement and not encountered in actual service shall be classified as nonrelevant. The following list itemize causes of failures which shall be classified nonrelevant. Nonrelevant failures shall not be used for the establishment of the formal accept/reject decision.

(1) Failures caused by human error of test personnel (e.g. positioning of switch incorrectly during test).

(2) Failures caused by malfunctions of test equipment or the test facility.

(3) Failures of any interconnecting item, such as wiring harnesses used in testing, which is not a part or component of normal equipment configuration in service applications.

(4) Failures which occur as a result of operation of the equipment in excess of specification limits, such as the application of excessive external voltages, loads, acceleration, and shock.

(5) A non-recurring phantom failure is indicated on test monitoring equipment which cannot be subsequently verified.

(6) Failures of the indicator lights and fuses.

(7) Failures occurring in the specimens during fault isolation, provided the time of operation of the equipment is not counted.

(8) Failures occurring during the repair verification portion of the test cycle after reinstatement into the chamber. The time of operating during this period shall contribute to the total only if a failure does not occur.

6.0 TEST OBJECTIVES AND EVALUATION

6.1 TEST OBJECTIVES

The primary test objectives are:

(1) Verify the reliability improvement factor for the proposed modification.

(2) Determine a reliability baseline, under the conditions of this test plan, for the modified and unmodified ICUs.

6.2 EVALUATION CRITERIA

The evaluation criteria will be as follows:

(1) The determination of the outcome of paragraph 6.1(1) above will be in accordance with paragraph 2.3 of this test plan.

(2) The determination of the values associated with paragraph 6.1(2) above will be accomplished using the Chi-Square distribution for confidence.

7.0 RELIABILITY TEST REPORT

7.1 TEST REPORT PREPARATION

The results of the reliability test conducted on the C-4453 Indicator Control Unit will be contained in a final test report compiled by MMERR.

7.2 TEST REPORT CONTENTS

The test of the final report will contain the following information

a. Test objectives

b. Brief statement of tests conducted in support of test objectives

c. Test configuration, including equipment, facilities and procedures

d. Brief statement of test results

e. Test evaluation

f. Problems encountered

g. Recommendations/conclusions

h. Test data (graphs, charts, tabulation)

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13. ABSTRACT

This document presents the results of the reliability testing performed on the C-4453/APQ-100 and C-6410/APQ-109 Radar Indicator Control Units (ICUs). This test is an essential part of the F-4 fire control system Increased Reliability of Operational Systems (IROS) program.

The reliability test was organically performed by the OOAMA Service Engineering Division at Hill AFB, Utah.

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